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PROJECT PLANNING AND DESIGN GUIDE

2.1 OVERVIEW

As used in this document, the term BMP refers to operational activities or physical controls that reduce the discharge of pollutants and minimize potential impacts upon receiving waters. There are two categories of BMPs within ADOT: Permanent Pollution Prevention BMPs and Temporary Pollution Prevention BMPs.

Permanent Pollution Prevention BMPs are permanent measures to improve storm water quality both during and after construction of the project. They include:

1. The minimization of impermeable surfaces;
2. The re-establishment of vegetation to disturbed soils (Figure 2.1);
3. The evaluation of increased runoff flows;
4. The preservation of existing vegetation;
5. The design of concentrated flow structures; and
6. The design of measures to protect disturbed slopes.

Figure 2.1 Revegetated cut slope

Figure 2.2 Installation of erosion control blanket

Temporary Pollution Prevention BMPs are temporary measures to improve storm water quality during the construction process. They include:

1. Temporary soil stabilization and sediment control (Figure 2.2);
2. Non-storm water management; and
3. Waste management.

The objective of this chapter is to provide guidelines for the consideration of permanent pollution prevention BMPs during the ADOT planning and design processes.

2.2 PROJECT PLANNING AND DESIGN

During the design process, the Landscape Architect and Engineer must endeavor to minimize the impacts to water quality that may be caused by the project. In order to maintain water quality affected by a project, ADOT has established the following objectives:

1. Maximize vegetated surfaces;
2. Stabilize disturbed soils;
3. Prevent downstream erosion.

The designer should consider the BMPs described in this chapter in order to achieve these objectives.

2.2.1. Evaluate Increased Runoff Flows

The project design may increase the amount of impermeable surface area within the project area, resulting in increased runoff quantities from the project site. The project design may also increase the velocities of existing offsite runoff flows by concentrating those flows into smaller drainage structures. Consequently, large storm events may result in greater peak runoff discharges into existing drainages than those drainages may have historically received.

To address these concerns, the designer shall consider the following:

- Drainage design: Bridges typically affect offsite runoff less significantly than do culverts and may be less visually intrusive;
- Bio-engineered designs such as live fascines and/ or pole plantings;
- Modifications to receiving drainages: the drainage may need to be protected by means of vegetation, geotextile mats, rock or riprap;
- Energy dissipation devices at culvert outlets;
- Reducing the turbulence and scour at culvert inlets and outlets by smoothing the transition between culvert inlets and outlets and drainages;
- Incorporating detention facilities into project design in order to reduce peak discharges; and
- Spread runoff flows across channel outlet structures in order to mimic natural drainage channels.

Figure 2.3 Preserving vegetation and limiting land disturbance are major factors in highway erosion prevention

2.2.2 Preservation of Existing Vegetation

Existing vegetation provides natural protection against soil erosion and should be preserved wherever possible (Figure 2.3). Mature plants have extensive root structures that help hold soil in place and reduce erosion. Vegetative foliage also helps reduce erosion by absorbing the impact of raindrops that would otherwise fall directly to the ground and erode the soil. Disturbed soils typically erode at much greater rates than do undisturbed soils.

Therefore, the designer should seek to minimize land disturbance by the following general guidelines:

- Minimize land disturbance through appropriate design to balance cut and fill and to reduce the length and steepness of the highway slopes and the extent of grading (typically, vegetation will not successfully colonize slopes greater than 2:1, H:V);
- Areas to be preserved should be delineated prior to the start of soil-disturbing activities. Vegetation that lies within transition areas of cuts or fills and outside of clear zones should be preserved in place;
- For larger projects, existing vegetation should be preserved for as long as possible where activity will occur later in the construction process;
- Temporary roads should be located to avoid stands of significant vegetation and to follow existing contours to reduce cutting and filling; and
- Temporary roads should be located within limits of area to be disturbed by permanent road construction.


Figure 2.4 and Figure 2.5 Swale with check dams

2.2.3 Concentrated Flow Structures

2.2.3.1 Ditches and Dikes

These are permanent devices used to intercept and direct surface runoff into a drain and/or into an existing drainage. Because they concentrate storm water runoff, they are highly susceptible to erosion. Therefore, the designer should consider the following:

- The drainage design should include calculations of peak flows and velocities for all drainage structures and should provide erosion control measures where erodable velocities occur (Table 2.1);
- To prevent downcutting, riprap should be considered for all ditches and dikes that exceed five percent slope; and
- Rock check dams reduce runoff velocity and capture sediment (Figures 2.4 and Figure 2.5).

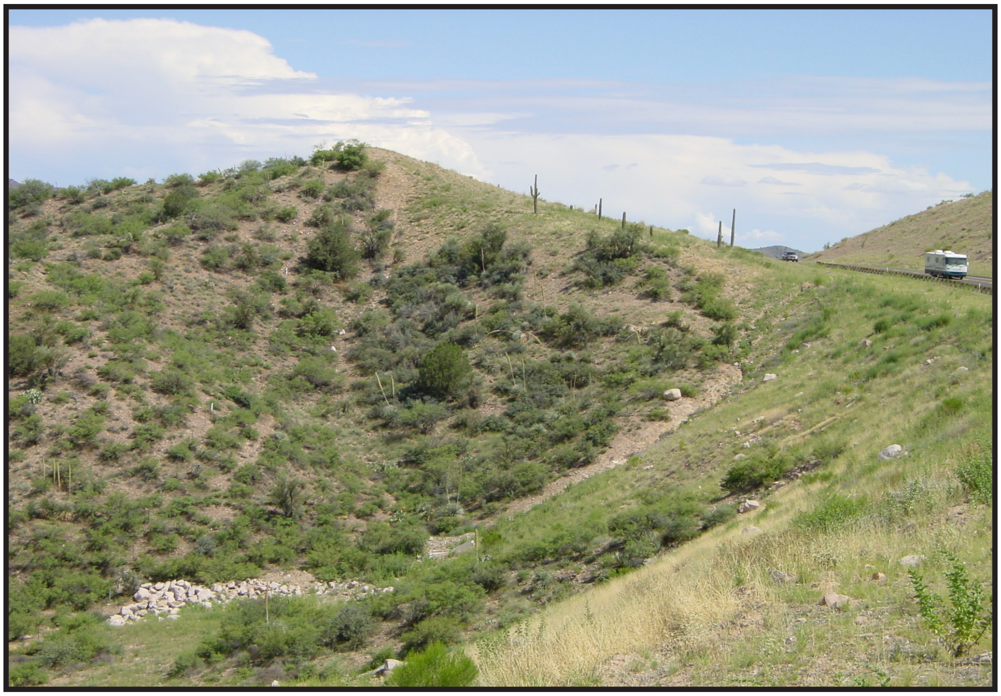

Figure 2.6 Cut fill transition

	Maximum	Permissible	Velocities For:
Soil Type or Lining (earth: no vegetation)	Clear Water	Water Carrying Fine Silts	Water Carrying Sand and Gravel
	F.P.S.	F.P.S.	F.P.S.
Fine sand (noncolloidal)	1.5	2.5	1.5
Sandy loam (noncolloidal)	1.7	2.5	2.0
Silt loam (noncolloidal)	2.0	3.0	2.0
Ordinary firm loam	2.5	3.5	2.2
Fine gravel	2.5	5.0	3.7
Stiff clay (very Colloidal)	3.7	5.0	3.0
Graded, loam to cobbles (noncolloidal)	3.7	5.0	5.0
Graded, silt to cobbles (colloidal)	4.0	5.5	5.0
Alluvial silts (noncolloidal)	2.0	3.5	2.0
Alluvial silts (colloidal)	3.7	5.0	3.0
Coarse gravel (noncolloidal)	4.0	6.0	6.5
Cobbles and shingles	5.0	5.5	6.5
Shales and hard pans	6.0	6.0	5.0

Table 2.1. Permissible Velocities for Channels with Erodible Linings, Based on Uniform Flow in Continuously Wet, Aged Channels[1]

[1]As recommended by Special Committee on Irrigation research, American Society of Civil Engineers, 1926.
From: FHWA - Hydraulic velocity by: 0.95 for slightly sinuous; 0.90 for moderately sinuous; and 0.80 for highly sinuous.

Figure 2.7 (left) Spillway (with failed temporary embankment curb)
Figure 2.8 (right) Culvert protection

Ditches and dikes also act as devices to prevent erosion. During the design process, the designer should consider the following:

- Crown ditches installed at the tops of slopes to divert runoff from adjacent cut slopes. Construction should take place prior to excavation of the slope. The designer should give careful consideration to crown ditch outlets to avoid downstream erosion and minimize ditch maintenance. In addition, since crown ditches can be highly visible to motorists, consideration should be given to ditch layout and existing vegetation. Finally, the designer should keep in mind that all ditches required maintenance; therefore, crown ditch access should be a consideration;
- Slope ditches: Installed at bottom and mid-slope locations to intercept sheet flow and convey concentrated flows;
- Embankment curbs: Installed on fill slopes at the edge of the roadway to intercept sheet flow from paved surfaces. Embankment curbs are of special consideration where the roadway is super-elevated, thereby directing all sheet flow to one side of the pavement; and

- Cut-to-fill slope transition protection: Installed at the intersection of cut and fill slopes. Cut ditches that discharge at cut-to-fill slope transitions will normally require erosion protection until runoff flows reach an existing stable drainage (Figure 2.6).

Figure 2.9 Rock rip rap at culvert

2.2.3.2 Overside Drains

Overside drains are pipes, downdrains and spillways used to protect slopes against erosion by collecting surface runoff and conveying it down the slope to a stabilized drainage. The designer should consider their use as follows:

- Cut slope spillway: Installed where offsite runoff will intercept a cut slope. Because cut slopes typically are highly visible to motorists, consideration should be given to the aesthetic design of these structures; and
- Fill slopes: Where embankment curbs are installed, openings in the curb are constructed that drain into a spillway or downdrain. Generally, downdrains are used for aesthetic reasons where slopes will be visible from a main roadway (Figure 2.7).

2.2.3.3 Culvert and Channel Outlets

Culvert and structural channel outlets are typically areas of high concern for erosion. The designer should consider the following:

- Careful review of inlet invert elevation: When lower than the existing natural channel, the channel backslope must be protected to avoid headcutting of that slope by runoff;

- Flared end section: These are typically installed at the inlets and outlets of pipes and channels to improve the hydraulic operation, retain the embankment near pipe conveyances and help prevent scour (Figure 2.8);
- Outlet protection/ velocity dissipation devices: In order to prevent scour at the outlet and to reduce runoff flow velocity, rock riprap or some other measure is typically installed. These devices should be constructed during or immediately after construction of the culvert; and
- Protection at the soil/ drainage structure interface: The interface between fill slope soils and concrete or metal structures is typically prone to erosion. While this interface frequently occurs at drainage structure outlets, it is also possible at the edges of spillways and bridge abutments. The designer should consider the use of rock or other protective measure to prevent erosion in this area (Figure 2.9).

2.2.4 Slope Protection

Surface protection consists of permanent design measures that are used alone or in combination to minimize erosion from disturbed surfaces. Vegetated surfaces may offer several advantages to paved surfaces including lower runoff volumes, slower runoff velocities, increased times of concentration and lower cost. However, where site-specific conditions would prevent adequate establishment and maintenance of a vegetative cover, hard surfacing should be considered.

2.2.4.1 Vegetated Surfaces

A vegetated surface is a permanent vegetative cover on areas that have been disturbed. The purpose of the vegetated surface is to prevent erosion and remove pollutants (including sediment) in storm water runoff. Vegetated surfaces should be established on areas of disturbed soil after construction related activities in that area are completed and after the slope has been prepared. Vegetated surfaces should only be considered for areas that can support the selected vegetation long-term. Typically, responsibility for treatment of vegetated slopes rests with the project Landscape Architect as follows:

- Project site shall be evaluated for soil types and conditions; topography; local climate and season; existing native vegetation types and species;
- Surfaces to be vegetated shall be designed to maximize rainfall infiltration and minimize concentrated flow volumes and speeds. Slopes shall be considered for roughening, terracing, and rounding; and
- Existing project site topsoil and vegetation shall be considered for salvage during clearing and grubbing operations. Use salvaged materials as part of surface preparation prior to seeding.

2.2.4.2 Hard Surfaces

Hard surfaces consist of placing concrete, rock or rock and mortar. Typically, these measures are considered where vegetation will not provide adequate erosion control and/or where vegetation will be difficult to maintain. The designer should to consider the downstream effects of increased runoff volumes and velocities from hard surfaces. Typical applications include bank protection and bridge abutments.

2.2.4.3 Erosion and Sediment Control Plans and Details.

As part of the project design process, the designer should develop plans and details which direct the contractor to the proper locations, installation and maintenance of BMPs. The intent of these plans is to provide general direction and specific BMP expectations to the contractor. They will not be considered a complete SWPPP and shall not replace the contractor's SWPPP, since the project plans and details are prepared assuming standard construction practices and may not reflect the contractor's actual methods of construction, access requirements or project phasing. The contractor shall use the project plans as a guide in developing his own SWPPP.

Figure 2.10 Installation of sediment wattles